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SPECIAL ISSUE

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Tracheostomy during COVID-19 pandemic—Novel approach

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Abstract

Background: This study describes a novel approach in reducing SARS-CoV-2 transmission during tracheostomy.

Methods: Five patients underwent tracheostomy between April 1, 2020 and April 17, 2020. A clear and sterile plastic drape was used as an additional physical barrier against droplets and aerosols. Operative diagnosis; droplet count and distribution on plastic sheet and face shields were documented.

Results: Tracheostomy was performed for patients with carcinoma of tonsil (n = 2) and nasopharynx (n = 1), and aspiration pneumonia (n = 2). Droplet contamination was noted on all plastic sheets (n = 5). Droplet contamination was most severe over the central surface at 91.5% (86.7%-100.0%) followed by the left and right lateral surfaces at 5.2% (6.7%-10.0%) and 3.3% (6.7%-10.0%), respectively. No droplet contamination was noted on all face shields.

Conclusion: Plastic drapes can help reduce viral transmission to health care providers during tracheostomy. Face shields may be spared which in turn helps to conserve resources during the novel coronavirus disease 2019 pandemic.

KEYWORDS

conservation of PPE, COVID-19, head and neck cancer, novel approach, tracheostomy

1 | INTRODUCTION

The novel coronavirus disease 2019 (COVID-19) is caused by SARS-CoV-2 virus. SARS-CoV-2 is found in high abundance in the upper aerodigestive tract mucosa.[1] It is known to be transmitted via close contact, droplet, and aerosols from aerosol generating procedures (AGP) such as tracheostomy.[2]

COVID-19 is associated with acute respiratory distress syndrome that requires patients to be intubated and may become dependent on mechanical ventilation. Patients with prolonged ventilation may require tracheostomy to optimize weaning from ventilatory support.[3] In Queen Mary Hospital, an experienced head and neck surgeon will be summoned to perform tracheostomy on such patients.

As head and neck surgeons, we are constantly exposed when resecting tumors arising from mucosa in the upper aerodigestive tract, in addition to tracheostomy and laryngectomy. Our patients may be asymptomatic at

the time of presentation, and there is currently no accurate way of COVID-19 diagnosis.[4,5] Hence, we are at particular risk of becoming infected when performing tracheostomy during the COVID-19 pandemic.

World Health Organization (WHO), Centres for Disease Control and Prevention (CDC), and Centre for Health Protection (CHP) recommend full barrier protection when performing AGP for unknown, suspected, and confirmed patients with COVID-19 in order to avoid disease transmission to health care providers. Such personal protective equipment (PPE) includes gloves, goggles, face shield, and gowns, as well as items filtering facepiece respirators such as N95 or powered air-purifying respirator hoods and aprons.[6-8]

The number of confirmed COVID-19 cases has soared since its first description in December 2019—as of April 18, 2020, there are 2 121 675 confirmed cases worldwide, of which Hong Kong accounts for 1024.[9,10] Such an escalation in the number of infected has resulted in a global shortage of PPE.

This study describes a novel approach which aims to decrease viral transmission when performing tracheostomy during the COVID-19 pandemic and at times of PPE shortage.

2 | MATERIALS AND METHODS

All patients who underwent tracheostomy in the Division of Head and Neck Surgery of the Department of Surgery, The University of Hong Kong at Queen Mary Hospital and Gleneagles Hong Kong Hospital between April 1, 2020 and April 17, 2020 were included.

All operations were performed by a consultant surgeon accompanied by one scrub nurse and one consultant anesthetist. Full barrier protection was adopted by all three parties. Intubation under general anesthesia was performed by anesthetist. Two horizontal anesthetic screen supports were then placed and secured with universal rotary clamps on patient's left bedside: One anesthetic screen support was placed at head level making sure not to limit the anesthetist's view and working space; the other was placed at the level of patient's umbilicus at a height of 20 cm from patient's truncal surface (Figure 1). The lower anesthetic screen could be placed further apart and set at a greater height to ensure adequate working space for the operating surgeon. Skin was prepared and draped with disposable surgical drapes (3M Hong Kong) in the usual manner for tracheostomy, exposing the inferior border of mandible, bilateral neck, and sternal angle. The two anesthetic screen supports were covered by surgical drapes.

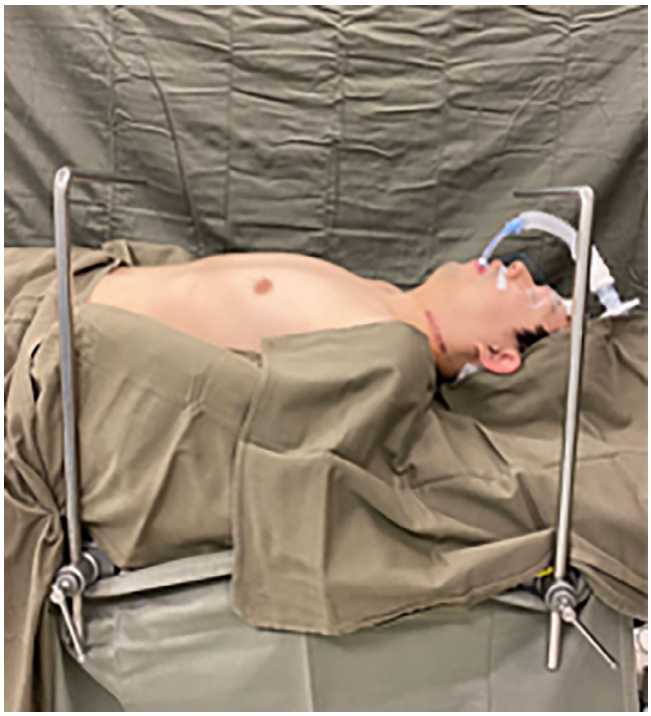

FIGURE 1 Placement of two horizontal anesthetic screens which were secured by universal rotary clamps on patient's left bedside [Color figure can be viewed at wileyonlinelibrary.com]

FIGURE 2 Placement of a piece of taut, clear, and sterile plastic sheet over the operative field. The sheet was fixed with sterile clamps on the two horizontal anesthetic screens. The caudal and left lateral edges were sealed with 3M adhesives [Color figure can be viewed at wileyonlinelibrary.com]

A clear and sterile plastic sheet measuring 120 cm × 140 cm was placed over the operating field. The sheet was then pulled taut and secured over the operating field using sterile clips for mounting on the two horizontal anesthetic screens. The caudal and left lateral edge of the plastic sheet was sealed using adhesive 3M

FIGURE 3 Placement of smoke evacuation suction catheter over the left upper corner [Color figure can be viewed at wileyonlinelibrary.com]

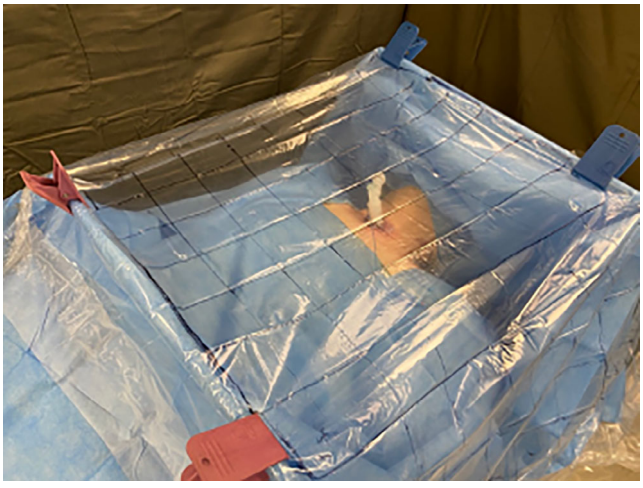

FIGURE 4 Placement of grids on plastic sheet on completion of tracheostomy [Color figure can be viewed at wileyonlinelibrary.com]

tape. The cranial end of the sterile drape was not taped to allow manipulation of endotracheal tube by anesthetist. The right side of the plastic sheet was not taped to allow the surgeon to operate from beneath (Figure 2). A 1 cm puncture was made over the left upper corner of the central operating field for placement of smoke evacuation suction tubing. The hole was sealed and tubing secured with Tegaderm (3M Hong Kong). Suction for smoke evacuation was only used during tissue dissection with monopolar diathermy prior to tracheotomy (Figure 3).

Scrub nurse was positioned opposite the surgeon's right hand. Tracheostomy was performed as described by Wei, ensuring good communication with our anesthetic colleague throughout the operation.[11] Skin incision was performed with scalpel knife, followed by soft tissue dissection with monopolar diathermy. Tracheotomy was performed with a scalpel knife after securing hemostasis and all suction devices switched off. After insertion of a cuffed Portex tracheostomy tube of appropriate size, the cuff was inflated. The tracheostomy tube was connected to a ventilator tubing which was passed under the plastic sheet and sterile drapes on the side of ventilator. Ventilation was resumed by the anesthetist once closed ventilation circuit was secured. Tracheostomy tube was secured with four stitches using 3/0 Nylon once successful ventilation was confirmed.

On completion of tracheostomy, the central and bilateral surfaces of the plastic sheet were marked with 7 cm × 7 cm grids (Figure 4) (Table 1). The face shield of surgeon and scrub nurse was removed after tracheostomy. The face shield used was a piece of optically clear, latex free plastic film measuring 32 cm in length and 22 cm in width with foam forehead cushion and elastic strap (A R Medicom Inc [Asia] Ltd.). It covered a full face length from forehead to neck, with outer edges of the face shield reaching bilateral ears. It had antifog and antiglare properties with no hearing restrictions. Each face shield was put against a white background with 12 grids measuring 7 cm × 7 cm each to facilitate counting at maximal magnification. Each plastic sheet

TABLE 1 Labeling of grids on plastic drape

R1	**R2**	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*C8*	*C9*	*C10*	*C11*	*C12*	*C13*	*C14*	***L4***	***L5***	***L6***
R5	**R6**	*C15*	*C16*	*C17*	*C18*	*C19*	*C20*	*C21*	***L7***	***L8***	***L9***
R7	**R8**	*C22*	*C23*	*C24*	*C25*	*C26*	*C27*	*C28*	***L10***	***L11***	***L12***
R9	**R10**	*C29*	*C30*	*C31*	*C32*	*C33*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***L17***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***

Note: **Bold** represents area of plastic drape on surgeon's side/patient's right side, labeled R1-16; *italics* represents area of plastic drape over center of operating field labeled C1-56; ***bold italics*** represents area of plastic drape opposite to surgeon/patient's left side, labeled L1-24.

TABLE 2 Droplet count and distribution for patients 1 to 5

Patient 1											
R1	**R2**	*C1*	*C2*	*C3*	*C4*	*1*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*C8*	*3*	*C10*	*C11*	*C12*	*C13*	*C14*	***L4***	***L5***	***L6***
1	**R6**	*C15*	*4*	*C17*	*2*	*C19*	*C20*	*1*	***L7***	***L8***	***L9***
R7	**R8**	*C22*	*C23*	*C24*	*1*	*C26*	*C27*	*C28*	***L10***	***L11***	***L12***
R9	**R10**	*C29*	*1*	*C31*	*C32*	*C33*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***1***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***
Patient 2											
R1	**R2**	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*C8*	*C9*	*C10*	*3*	*C12*	*C13*	*C14*	***L4***	***L5***	***L6***
R5	**R6**	*C15*	*C16*	*2*	*C18*	*C19*	*1*	*C21*	***L7***	***L8***	***L9***
R7	**R8**	*C22*	*2*	*C24*	*C25*	*2*	*C27*	*1*	***L10***	***L11***	***L12***
R9	**R10**	*C29*	*C30*	*1*	*C32*	*C33*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***L17***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***
Patient 3											
R1	**R2**	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*C8*	*C9*	*C10*	*C11*	*2*	*C13*	*C14*	***L4***	***L5***	***L6***
R5	**1**	*C15*	*C16*	*3*	*C18*	*C19*	*C20*	*C21*	***L7***	***L8***	***L9***
R7	**R8**	*1*	*C23*	*C24*	*2*	*C26*	*C27*	*C28*	***L10***	***L11***	***L12***
R9	**R10**	*C29*	*C30*	*C31*	*C32*	*1*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***L17***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***
Patient 4											
R1	**R2**	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*1*	*C9*	*2*	*C11*	*C12*	*1*	*C14*	***L4***	***L5***	***L6***
R5	**R6**	*C15*	*1*	*C17*	*1*	*C19*	*C20*	*C21*	***1***	***L8***	***L9***
R7	**R8**	*C22*	*C23*	*C24*	*3*	*C26*	*C27*	*C28*	***L10***	***L11***	***L12***
R9	**R10**	*C29*	*C30*	*C31*	*C32*	*C33*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***L17***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***
Patient 5											
R1	**R2**	*C1*	*C2*	*C3*	*C4*	*C5*	*C6*	*C7*	***L1***	***L2***	***L3***
R3	**R4**	*C8*	*1*	*C10*	*C11*	*C12*	*2*	*C14*	***L4***	***L5***	***L6***
R5	**R6**	*C15*	*C16*	*C17*	*2*	*C19*	*C20*	*C21*	***L7***	***L8***	***L9***
R7	**R8**	*C22*	*C23*	*2*	*1*	*C26*	*C27*	*C28*	***1***	***L11***	***L12***
R9	**R10**	*C29*	*2*	*C31*	*C32*	*C33*	*C34*	*C35*	***L13***	***L14***	***L15***
R11	**R12**	*C36*	*C37*	*C38*	*C39*	*C40*	*C41*	*C42*	***L16***	***L17***	***L18***
R13	**R14**	*C43*	*C44*	*C45*	*C46*	*C47*	*C48*	*C49*	***L19***	***L20***	***L21***
R15	**R16**	*C50*	*C51*	*C52*	*C53*	*C54*	*C55*	*C56*	***L22***	***L23***	***L24***

TABLE 3 Total droplet count and distribution of droplets for patients 1 to 5

	A	B	C	D	E	F[a]	G	H	I	J	K	L	
1	**1**	**0**	*0*	*8*	*0*	*3*	*1*	*0*	*1*	***0***	***1***	***0***	15
2	**0**	**0**	*0*	*2*	*3*	*3*	*2*	*1*	*1*	***0***	***0***	***0***	12
3	**0**	**1**	*1*	*0*	*3*	*2*	*3*	*0*	*0*	***0***	***0***	***0***	10
4	**0**	**0**	*1*	*1*	*2*	*4*	*0*	*1*	*0*	***1***	***0***	***0***	10
5	**0**	**0**	*0*	*3*	*2*	*3*	*0*	*2*	*0*	***1***	***0***	***0***	11
	1	**1**	*2*	*14*	*10*	*15*	*6*	*4*	*2*	***2***	***1***	***0***	58

Note: A—R1,3,5,7,9,11,13,15; B—R2,4,6,8,10,12,14,16; C—C1,8,15,22,29,36,43,50; D—C2,9,16,23,30,37,44,51; E—C3,10,17,24,31,38,45,52; F—C4,11,18,25,32,39,46,53; G—C5,12,19,26,33,40,47,54; H—C6,13,20,27,34,41,48,55; I—C7,14,21,28,35,42,49,56; J—L1,4,7,10,13,16,19,22; K—L2,5,8,11,14,17,20,23; L—L3,6,9,12,15,18,21,24.

[a]Center-most column.

was carefully removed and placed against a white background for counting.

The number and size of droplets splashed in each grid of the plastic sheet and face shield was counted using the surgical microscope Leica M720 0H5 (Leica Microsystems GmbH, Germany). The plastic sheets and face shields were discarded once counting was complete.

Operative diagnosis; operation duration; size, number, and distribution of droplets on plastic shield and face shield for each party were documented.

3 | RESULTS

Five patients with no clinical evidence of COVID-19 underwent tracheostomy: two patients who underwent radical tonsillectomy, modified radical neck dissection, and free anterolateral thigh flap reconstruction for carcinoma of tonsil; one patient who underwent maxillary swing nasopharyngectomy for recurrent nasopharyngeal carcinoma; and two patients who underwent tracheostomy for aspiration pneumonia and sputum retention. Average operation duration was 352.4 (338.0-365.0) seconds. Droplet contamination was noted on all five plastic sheets (Table 2). Droplet size ranged from 0.2 to 2.8 mm. Droplet contamination was most severe over the central surface for all patients with an average of 91.5% (86.7%-100.0%) followed by the left lateral surface and right lateral surface at 5.2% (6.7%-10.0%) and 3.3% (6.7%-10.0%), respectively (Table 3).

Droplet count contamination was mainly over the central upper half of plastic sheet overlying the site of operation in the lower neck. Total droplet count was highest along the center-most column F at 25.9% (n = 15). Droplet count decreased toward the periphery on both sides. The decline was greater on the left lateral surface at 10.3% (n = 6), 6.9% (n = 4), 3.4% (n = 2), 3.4% (n = 2), 1.7% (n = 1), and 0% along columns G, H, I, J, K, and L, respectively, compared with columns E, D, C, B, and A at 17.2% (n = 10), 24.1% (n = 14), 3.4% (n = 2), 1.7% (n = 1), and 1.7% (n = 1), respectively, on the right lateral surface (Table 3).

No droplet splash was documented on face shields of both the surgeon and scrub nurse for all patients.

4 | DISCUSSION

SARS-CoV-2 is transmitted through close contact and droplets. Airborne transmission may occur during AGP including tracheal intubation, noninvasive ventilation, tracheotomy, cardiopulmonary resuscitation, manual ventilation before intubation, and bronchoscopy.

In view of the recent COVID-19 pandemic, tracheostomy guidelines and protocols have been revisited and updated with the aim of decreasing aerosol generation and viral transmission to health care providers. These include patient selection; timing of operation in relation to symptoms, quarantine duration and polymerase chain reaction test results; location of surgery; PPE requirements; minimizing the number of health care providers; expertise in performing intubation and tracheostomy; and ways to decrease exposure to aerosolized secretions intraoperatively.[3,11-13]

WHO, CDC, and CHP advocates full barrier protection when performing AGP including a face shield which acts as an additional physical barrier against splashes, sprays, and spatter of body fluids. However, the use of face shield hinders the use of a head-light when performing head and neck surgery. Prolonged use can give rise to fogging, carbon dioxide retention especially when combined with respirator, and impaired communication. Furthermore, as the number of infected patients increases world-wide, there is a global shortage of PPE. As a result strategies have been formulated

to optimize PPE availability include minimizing the need for PPE in health care settings, and ensuring rational and appropriate use of PPE.

In this study, we proposed the use of two horizontal anesthetic screens and a clear sterile plastic sheet draped over a tracheostomy operative field. The rationale is to create a spacious and sterile closed environment for the surgeon to work in while preventing droplet and aerosol escape during the procedure, ultimately reducing the chance of viral transmission. Such a set-up is readily available, functional, non-time-consuming, and cost effective.

The two horizontal anesthetic screens acted as struts. The height and distance of which could be adjusted by the surgeon to ensure adequate working space while not obstructing anesthetist's view and working space at the cranial end. Surgical drapes were placed loosely over the two anesthetic screens so that it conformed to the contour of the screens, resulting in a sterile and flat cranial and caudal surface, thereby increasing working space. Finally placement of a clear and sterile plastic sheet over the two anesthetic screens and sealing over the caudal and left lateral edges helped to create a sterile box-like working area for the surgeon. It was imperative that the plastic sheet was pulled taut over the operative field so as not to compromise visibility. A long length of plastic sheet was allowed to drape over the cranial end without fixing to allow anesthetist to reach the endotracheal tube. A length of plastic sheet measuring 14 cm over the right lateral surface acted as a hood against droplet and aerosol spillage, under which the surgeon's hands passed. Skin incision was performed using a scalpel knife followed by soft tissue dissection with monopolar diathermy. A suction catheter for smoke evacuation was placed over the surgeon's contralateral side to prevent fogging and impaired visibility. On reaching the anterior tracheal wall, hemostasis was secured. Suction was then turned off prior to tracheotomy. In order to minimize aerosol exposure, complete paralysis of the patient was ascertained throughout the procedure; mechanical ventilation was stopped prior to tracheotomy; suction was not used during and after tracheotomy; all tracheostomies were performed by consultant surgeons, consultant anesthetists, and scrub nurses experienced in the management of airways and the procedure. Such a set-up did not adversely affect visibility and efficiency in performing tracheostomy as evidenced by an average operation duration of under 6 minutes.

Our study demonstrated that despite meticulous tissue dissection and hemostasis, swift and bloodless tracheotomy, there was droplet contamination noted on plastic sheets of all five patients. Droplet contamination was centered over the lower neck which corresponded to the operating site for all patients. Droplet count decreased toward the periphery. The drop was less pronounced toward the right side where the surgeon stood and operated on. Droplet count was also noted on the right lateral surface of the plastic sheet, which acted as a hood further protecting the surgeon against droplet and aerosol contamination. The lack of droplet contamination on face shields of the surgeon and scrub nurse implied that the plastic sheet was effective in preventing droplet and aerosol spillage.

Results from our preliminary study suggested that the use of two horizontal anesthetic screens and a clear sterile plastic sheet draped over a tracheostomy operative field can effectively prevent droplet contamination, obviating the need for a face shield given adequate eye protection and respirator. Such an approach can also be advocated for other AGP in an attempt to reduce droplet and aerosol contamination, and ultimately viral transmission to health care providers.

Larger scale studies with more patients and operating surgeons is warranted to justify such recommendations. Given the effectiveness of the plastic sheet in preventing droplet contamination, the role and efficacy of N95 respirator vs medical masks in preventing viral transmission can be reassessed.

5 | CONCLUSION

The use of two horizontal anesthetic screens and a sheet of clear sterile plastic drape effectively creates a closed sterile environment for the surgeon to perform AGP on all unknown, suspected, and confirmed patients with COVID-19, while minimizing the chance of droplet contamination and viral transmission to health care providers. Such a set-up is functional, readily available, and cost effective. PPE such as face shield can be conserved. The aforementioned approach should be considered to support safe clinical practice and efficient use of resources during the COVID-19 pandemic.

CONFLICT OF INTEREST

The authors declare no conflicts of interest. This paper is not based on previous communication to a society or meeting.

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